How to Develop an Effective Solid Waste Collection Program

A Primer for Solid Waste Collection in Manado, North Sulawesi, Indonesia

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DEVELOPING EFFECTIVE SOLID WASTE COLLECTION SERVICES

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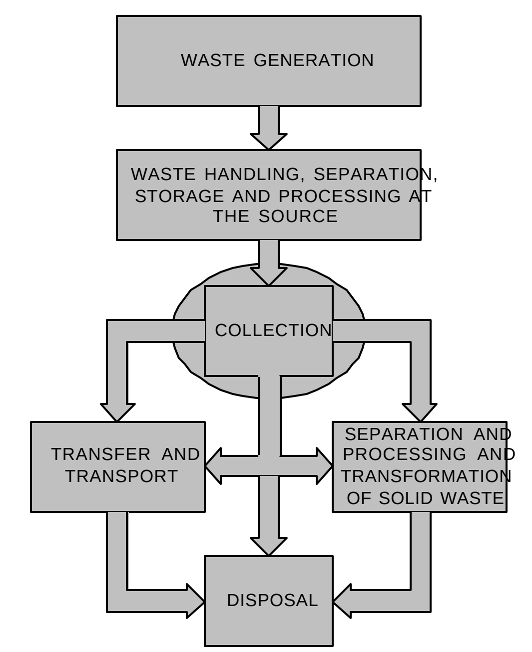
DEVELOPING EFFECTIVE SOLID WASTE COLLECTION SERVICES IN MANADO

1. USER'S GUIDE

This manual is intended to provide a basic level of knowledge concerning effective and sustainable solid waste collection in Manado. In its approach, the manual presents background information concerning the principle work tasks associated with achieving effective primary solid waste collection (under the jurisdiction of the kelurahan and linkgungan) and secondary transfer (under the jurisdiction of the municipal solid waste agency or kecamatan districts). To that end, information is provided to help the people responsible for solid waste collection and transfer in these levels of government:

1. **Assess** current collection practices
2. **Design** a primary collection and secondary transfer system
3. **Operate and maintain** the primary collection and secondary transfer system to preserve its effectiveness after all resources are in place and designated responsibilities have been assumed.

Solid waste collection and transfer is a very important function and is an integral part of integrated solid waste management programs. Its importance is due to the fact that it is one of the most visible public services and failure in the collection system is reflected by conditions that everybody can see in the streets and drainage structures throughout the city. The role of collection and transfer in an integrated solid waste management (ISWM) program is shown in Figure 1.1 to the right. All of the ISWM elements are important and problems in any one component can affect the success of the others. In addition, the responsibility for each function involves many stakeholders including solid waste generators and the various layers of government in Manado. Because of this there will need to be considerable interaction between all of the stakeholders if the overall solid waste management program is to be successful. This primer attempts to educate solid waste managers at all levels of government in Manado understand their responsibilities and the manner in which they can provide their services in an efficient and sustainable manner.



COLLECTION ROLE IN SOLID WASTE MANAGEMENT

2. ASSESSING CURRENT COLLECTION PRACTICES AND CONDITIONS

The starting point for any program aimed at achieving effective solid waste collection is an assessment of current collection practices and conditions. It is extremely important that both the hard aspects (containers, vehicles, transfer points, transfer stations, etc.) and the soft issues (scheduling, route structures, fee systems, legal/political framework, etc.) be evaluated and viewed geographically and politically to determine that they are appropriate to the setting in which collection and transfer is to occur.

2.1 Determine Community Goals And Constraints

The inability to manage urban solid waste in any community may be due to problems and failures in a number of areas, including:

- Inadequate services and level of coverage
- Inadequate financing
- Random and substandard uncontrolled dumps,
- Inadequate environmental controls throughout the solid waste management program,
- Poor institutional structure including ineffective laws and regulations that do not mandate sound practices, and
- Inadequate sanitation practices by solid waste generators.

Basically, those responsible for solid waste management must seek to address the above problems by establishing community objectives aimed at solving the problems. The objectives must attempt to answer the following questions:

- **Fundamental Changes in the Required Collection Structure –**What impact will the establishment of new regional disposal facilities have on collection practices and the need for secondary transfer?
- **Level of service:** What level of service is required to meet the communities' needs? What expectations exist with respect to the frequency of pickup and the convenience of set-out or communal collection requirements for solid waste generators at the local government level?
- **Roles for the public and private sectors:** Is there a policy preference regarding the roles of the public and private sectors in providing waste collection services? How will the informal private sector participate in the program? Is the informal private sector apt to be an impediment to achieving effective collection?
- **System funding:** How can any improvements in solid waste collection be funded at either the local government or SWM Council level?

Each of the above issues is influenced by a number of factors that often constrain the development and implementation of effective solid waste management systems. These include:

- **Technical Constraints** – Is there sufficient technical expertise to design effective collection systems?

- **Financial and Economic Constraints** – Are sufficient funds available to finance the required improvements and systems?
- **Institutional Constraints** – Are the rules and regulations in the region strong enough to mandate effective collection and transfer practices? Are existing laws and regulations enforced?

Those responsible for collection must understand the nature and local aspects of these constraints so as to establish reasonable objectives for solid waste collection that are sustainable in the region.

2.2 Establish Sustainable Objectives for Effective Collection And Transfer

The development of an effective collection system requires that a desired level of service be defined. The frequency of routine collection and the type of collection service provided to solid waste generators commonly defines **Level of Service**. Type of service will influence the local government level of service and, ultimately, the cost of collection. Whether a collection crew picks up solid waste at specific set-out location such as curbside or backyards determines the time required for each collection stop and ultimately the costs associated with that stop. Curbside collection requires that residents place waste containers at curbside on a designated day. This is usually less expensive than backyard service but significantly more expensive than communal collection configurations. The use of central collection through strategically placed containers can decrease the cost of collection by focusing collection to common locations that serve many residential waste generators.

2.3 Define Sustainable Practices for Solid Waste Collection In The Region

One of the most difficult municipal problems in any country is the management of solid waste generated within them. Deficiencies in the management of solid waste is often pronounced in the villages, towns and cities of developing countries where poorer or remote areas often receive little or no service. In other areas, the level of service is often inconsistent or below a desired standard. Solid waste collection is one of the most visible services provided in any community and the failure of a collection program is often the reason why people feel that a solid waste management program is ineffective. While few people come in direct contact with dump areas, everybody will come into contact with the collection system in some form.

Figure 2-1 - Improperly Serviced Containers

The primary objective of solid waste collection is to simply provide physical separation of solid waste from its generators and the processing or disposal facilities to which the solid waste is ultimately delivered. Unfortunately, collection is one of comprehensive solid waste management program's most difficult and complex components. From an economic viewpoint, solid waste collection is usually that element of a solid waste program that costs the most. In industrialized countries, collection accounts for approximately 60 to 70 percent of the total cost of solid waste management while, in developing countries, collection can be up to 70 to 90 percent of the total costs. Jointly, collection and street sweeping often comprise the largest category of expenditures in many municipal budgets. The magnitude of these expenditures is justified, however, since the failure or inadequacy of a collection system can have significant public health effects and can affect the quality of life where people live and work. In many developing countries, the following generally apply to solid waste collection:

1. Waste collection and street sweeping are often very inefficient and the level of service is low;
2. Workers are often poorly motivated, untrained, and poorly compensated;
3. Collection workers are often equipped with obsolete or barely functioning equipment with no backup equipment to maintain a consistent level of service;
4. Collection routes often do not keep up with rapid urban growth; and
5. There is a major difference between the levels of service in poor areas from more affluent areas.
6. Solid waste generators must often bring waste materials long distances to containers that are often difficult to use and frequently overflowing due to an inability to keep them serviced.
7. Collection activities in developing countries often include a strong involvement of the informal sector such as small businesses or poor individuals who subsist on materials recovered from waste streams.
8. The use of muscle-powered vehicles such as hand or animal-drawn carts is common.

Alternative solid waste collection and transfer configurations - There are a number of different methods for collecting solid waste; many of which focus on the alternative interface points between the waste generators and the entry of their waste into the formal collection program. The following factors have a direct bearing on the collection system choices for any particular situation or location:

1. **Waste generation rate** - The rate of waste generation has a significant impact on the collection system and its technical choices (vehicles, containers, etc.). The more affluent a community, the greater will be the rate at which it generates solid waste. In developing countries, the average generation rate is within the range of 0.3 to 0.5 kilograms per capita per day.
2. **Waste density** - The density of waste varies depending on the relative affluence of the community and the way in which waste is handled and stored. The waste in developing countries is naturally dense, ranging between 300 to 500 kg/m^3. Compaction trucks are typically designed to compact light refuse to about 100 to 400 kg/m^3. Therefore, developing countries may require little or no compaction. This may negate the value of technically complex collection vehicles or compactor based transfer stations such as those found in industrialized countries.
3. **Transport conditions -** Road conditions, traffic density and haul distance have a significant influence on collection and transfer vehicle choices.

There are four basic primary solid waste collection approaches available to the local governments to accomplish primary collection, including:

1. Communal collection,
2. Block collection (also referred to as just-in-time collection),

3. Curbside/alley collection, and
4. Door-to-door collection.

In communal collection, a public place is defined as a communal collection point and shared by the community for collection. In block collection, a collection vehicle stops at a convenient place and generators deliver their waste to the vehicle at the designated time of collection. In curbside collection, the householders put out their waste containers that they retrieve later after collection is completed. In door-to-door collection, a collector enters the premises for collection of the waste.

As would be expected, the choice of an approach to collection will influence the convenience of the collection system for the public. Unfortunately, as is the case with many things, increased convenience often translates into increased cost. Various advantages and disadvantages of each of the approaches commonly used in regions similar to Manado are as follows:

Communal Collection - One crucial aspect of using a communal collection approach is the decisions as to where containers are placed. These points can consist of street corners, several locations on densely populated streets, or at the edge of neighborhoods or villages accessible to generators and collection vehicles.

One of the main advantages of communal collection points is that they allow a household to potentially have continual access to a disposal point. Conversely, if a communal collection point receives little attention, containers may overflow and cause problems such as odors and insects. In some cases, residents near communal collection points have started fires to minimize odors or insects. This, in turn, increases the health exposure of improper solid waste management to an even larger number of people as a result of the smoke from the fires.

Figure 2-2
Burning Waste in Communal Containers

Sound practice in communal collection design requires that solid waste managers understand the potential conflict that exists between the need to accomplish public convenience and the strategies required to maintain cleanliness and sanitary conditions around communal containers. They must also strategize how to control waste pickers, odors, animals and vectors who affect conditions around communal containers. Sound practice requires that there are an adequate number of containers distributed at appropriately located collection points. These containers must be easy to use even for children who are often called upon by their parents to bring solid waste to the communal collection point. Sound practice also requires that program managers commit to carry out frequent collection and cleanup overflows as they occur for whatever reason. Basic advantages and

Figure 2-3
Improperly Service Containers with Burning Waste

disadvantages to the communal collection approach are as follows:

Advantages:

- Drop-off in a communal container is the least expensive of methods.
- This method involves lower collection staffing requirements that the other methods.

Disadvantages:

- Residents are inconvenienced by having to bring their waste to the collection point.
- There is increased risk of injury to residents.
- Illegal dumping/scavenging may occur leading to waste accumulation near the container.

Curb-side/Alley Collection – This method of collection is common in industrialized countries. Advantages and disadvantages of this approach are as follows:

Advantages:

- Collection crew can move quickly from one collection stop to another.
- Collection crew does not enter private property.
- This method is less costly than backyard collection because it generally requires less time and fewer collection personnel to access the solid waste and.
- The approach is adaptable to automated and semi-automated collection equipment.

Disadvantages:

- On collection days, waste containers are visible from street.
- Collection days must follow a consistent and reliable schedule.
- Residents are responsible for placing containers at the proper collection point.
- The cost of this level of service may be prohibitive in areas with limited resources

The following are general conclusions relative to the various types of collection systems.

1. Communal storage systems probably offer the lowest collection costs and most flexibility in most developing countries.
2. Block collections at fixed time intervals appears to offer low collection costs and avoids the problems that arise with communal storage or curbside collection but requires consistent and reliable application for success. One disadvantage, however, is that it requires that somebody be at home at the time that the truck arrives at the collection point for waste collection.
3. Door-to-door or curbside/alley collection using motor vehicles and collection crews will usually be the most expensive system.

Primary Collection Vehicles - Solid waste managers must choose vehicles that are suited to the characteristics of the collection service area. Primary collection vehicles can range from muscle powered carts and wagons to sophisticated solid waste compactors. Examples of various collection equipment and vehicles are shown on the following pages.

There are a number of issues that can affect vehicle selection including 1) anticipated service levels, 2) crew size, 3) collection route characteristics and 4) budgetary constraints.

Figure 2.4
Examples of Handcarts and Tricycles

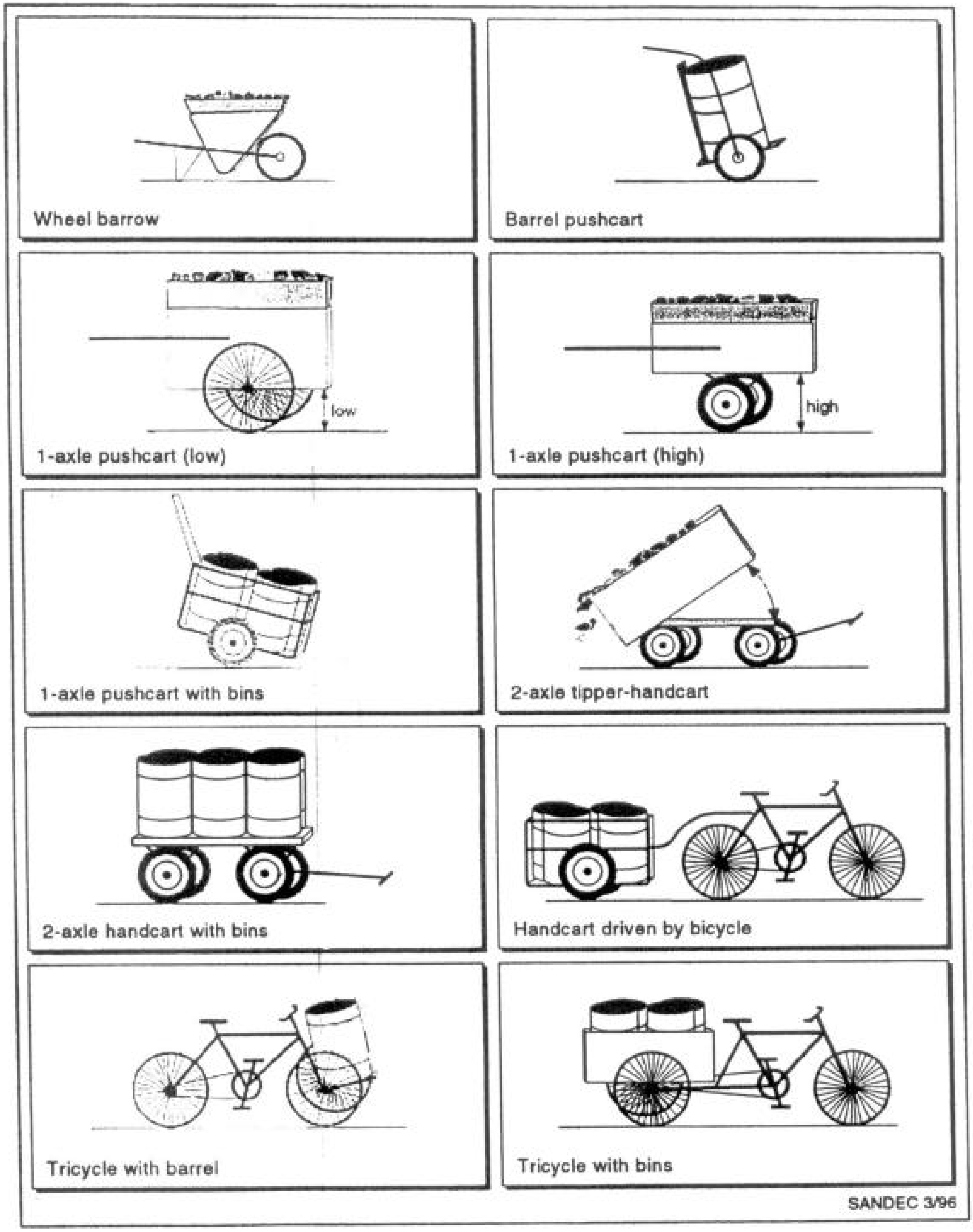


Figure 2.5
Examples of Motorized Vehicles

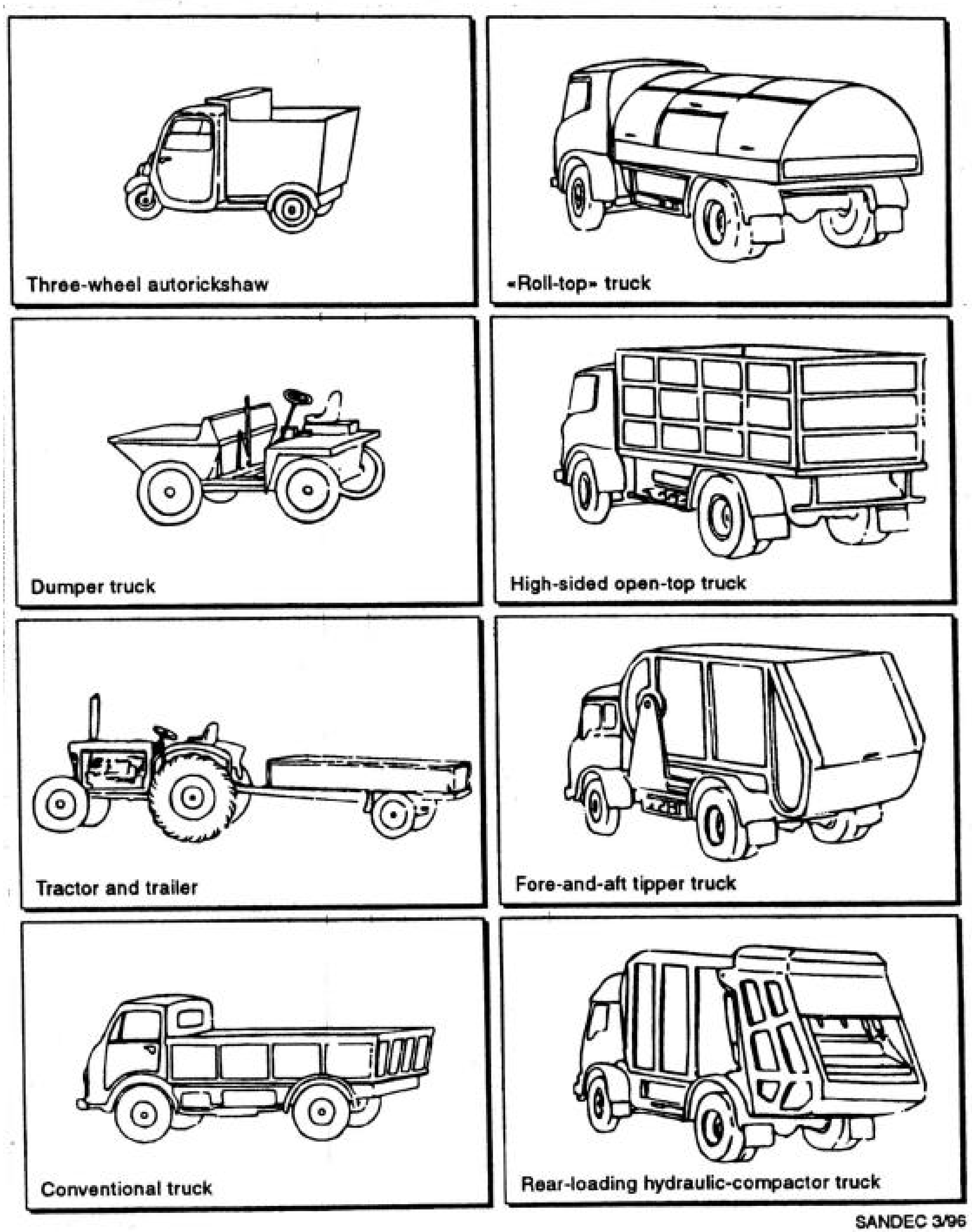


Figure 2-6 - Open Collection Truck

Conventional dump trucks are often used in solid waste collection. These have the advantage of being readily versatile and available in most countries. Repair and maintenance is less specialized (and therefore less costly) than that for vehicles designed solely for the purpose of collecting solid waste.

Waste compaction vehicles are normally classified by loading characteristics and are classified as either rear-loaded or side-loaded. Rear load trucks are best suited to areas that have a high population and where there are frequent and numerous collection stops. This loading configuration allows both sides of a street or alley to be collected at the same time. Side loaded vehicles are best suited to densely populated areas where collection takes place in only one side of the street or for rural routes.

Figure 2-7 – Front Loader Compaction Collection Vehicle

Solid waste must also be collected from commercial establishments and industries as well as residences. Typically, commercial waste differs in both quantity and composition from residential waste and is usually stored in large containers prior to pick up. Rear loading and side loading trucks similar to those used in municipal solid waste collection are often used. Also, front loading, and drop-off truck configurations are also used. Front loading equipment is designed for use with specifically designed containers. After a front-loading truck maneuvers to the container, the container is picked up by hydraulic arms, lifted over the truck cab, and discharged into a hopper in the top of the rear compaction body.

Trucks that are equipped to physically pick up drop-off containers are also frequently used for the collection of industrial and commercial waste. In this case, collection containers are physically picked up, transported to a disposal or processing location, emptied, and returned to the point of origin on the same truck. Two forms of

Figure 2-8 – Commercial Containers

Figure 2-9
Tilt Frame Roll-off Truck

this truck type are normally used. A dumpster type allows a container to be lifted onto a truck by hydraulically actuated arms attached near the rear of the truck. The other type uses a tilting frame that moves roll-off containers on and off using a chain or cable.

Some of the advantages and disadvantages of the predominant types of solid waste collection vehicles are described below:

Muscle powered vehicles

Advantages:

1. Particularly suited in densely populated areas with minimal street access or unpaved streets

Figure 2-10 – Donkey Drawn Cart

2. Suited for squatter settlements and in rough terrain.
3. Where a relatively small volume of waste from a relatively large number of densely settled housing units must be collected.
4. Such vehicles are often inexpensive and easy to build or maintain.

Disadvantages:

1. The public perception that the use of such vehicles is old-fashioned and inefficient.
2. Limited traveling range and slowness.
3. When vehicles are pulled by animals, waste materials from these animals must be cleanup.
4. More greatly affected by weather conditions and exposure.
5. More susceptible to decreased efficiency due to animal temperament and health of collectors.

Non-compactor trucks

Advantages:

1. Quite efficient when waste is generally wet or dense

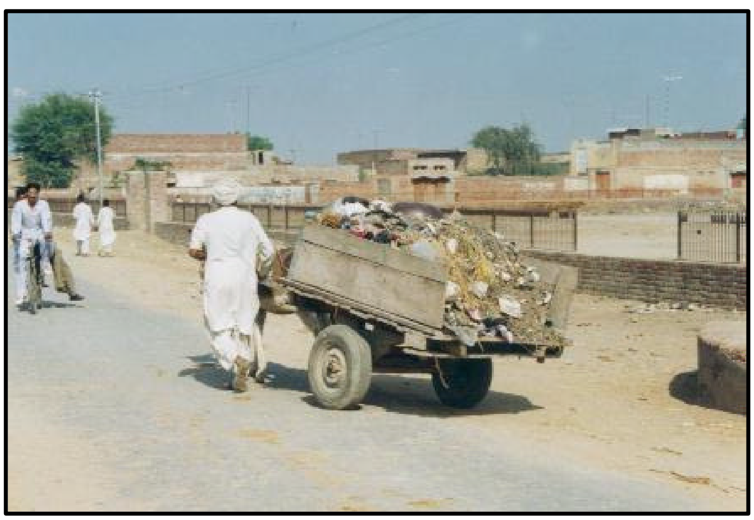


Figure 2-11 – Muscle Powered Collection Cart

Figure 2-12 – Small Collection Vehicle

2. Practical where labor is inexpensive
3. Practical where there is limited access to skilled maintenance for more complex vehicles
4. Collection routes are long and relatively sparsely populated
5. Tucks are potentially universally available from local sources
6. Trucks are flexible to perform a number of different collection tasks.

Disadvantages:

Figure 2-13 – Open Body Dump Truck

1. Waste loads often have to be covered while transporting waste to transfer, processing or disposal points so as to prevent the deposition of waste from the trucks onto roads.
2. Some non-compactor trucks often do not have an automatic means for offloading solid waste.
3. Many government officials believe that a modern efficient collection program must include compaction vehicles and that non-compactor vehicles represent lower efficiency.
4. Donor agencies tend to recommend equipment used in their own countries and they tend to assume that compactor trucks represent the best use of their donated money.

Figure 2-14 – Rear Loaded Compactor

Compactor trucks - These trucks are the standard of sound practice in most industrialized countries where their cost can be afforded. These trucks have been designed specifically for the purpose of collecting solid waste.

Advantages:

1. Allow waste to be placed into the vehicle from either the rear or side of the vehicle.

2. Compacts the waste to a higher density using either hydraulic or mechanical pressure
3. Hides the waste from the public thereby adding to the invisibility of the collection system.
4. Prevents vectors from reaching the waste after it has been placed into a compactor truck.

Disadvantages:

1. High capital cost
2. They are designed for a limited purpose with little flexibility for alternative use.
3. Significant amount of mechanical mechanisms that require specialized maintenance

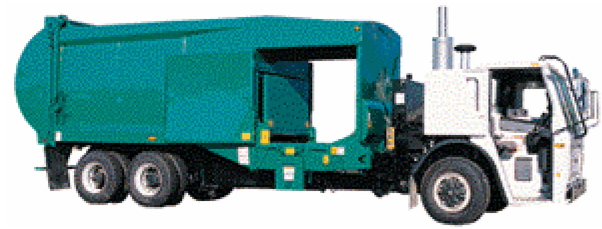


Figure 2-15 – Side Loaded Compactor

4. High fuel usage with the resulting high operating costs,
5. Requires paved streets wide enough to allow passage and turning during collection,
6. The waste must be set out in containers or bags so that the collection crew can to pick them up

3. DESIGNING AN EFFECTIVE COLLECTION SYSTEM

3.1 Characterize the Existing Collection System

The starting point for the design of an effective solid waste collection system is a characterization of the existing system and practices. The following are a number of factors to be evaluated prior to deciding what collection modifications are warranted.

Estimate the quantity and composition of solid waste in the service area - While the total solid waste quantity and composition is important in the design of disposal facilities, the design of a collection and transfer system must evaluate the amount of solid waste generated in the individual segments of the collection service area or in the service areas served by individual transfer stations.

Define the physical characteristics of collection service areas - The physical characteristics (topography, road networks, access to collection points, etc.) of the primary collection service area can have a major impact on collection design. The accessibility of roads within the collection area is crucial in determining the types of vehicles that can be used in the collection program. Transportation patterns within the service area will determine which roads will be difficult to use during peak traffic periods.

Develop an asset inventory - Solid waste planners should develop an asset inventory for their collection system. This inventory should include all physical assets (trucks, containers, etc.) and personnel dedicated to the collection process. It should also include temporary assets periodically applied to the collection process. If communal containers are used, their number and location should be shown on a collection system plan that shows the extent of container placement and areas served.

Define existing collection routes - If curbside collection is utilized, an existing route map should be developed to show the extent and configuration of the collection route structure.

Determine the effectiveness of the existing collection system - An efficient collection system collects as much waste as possible with a given amount of labor and capital in as short a period as possible. The effectiveness of the existing collection system can be evaluated in a number of ways. If the system uses communal collection, the accumulation of solid waste outside of collection containers may be an indication that the containers are not serviced frequently enough.

Crew productivity is an important measure of collection efficiency. The factors that influence crew productivity include route structure, service level, collection equipment and the personal characteristics of the crew members. The collection vehicles can affect crew productivity through loading location, loading height, vehicle capacity, compaction density, and the age/condition of the truck. The individual crew member factors that can affect productivity include age, attitudes toward their work, and health. The basic means by which crew productivity can be measured is by simply observing the collection process to determine a practical level of performance that should be expected from collection crews on a regular and measurable basis. Time study observations are required to determine how a collection crew spends its time in performing its duties.

Identify collection system deficiencies – Because of the visibility of collection services, system deficiencies can be determined by the extent of waste accumulation outside of the collection components. Complaints are another gauge of system performance and deficiencies. The extent of collection vehicle breakdowns and their impact on the level of service can also be an indication of system deficiencies.

Identify actual collection costs through full cost accounting – Proper design requires that solid waste managers understand the total costs associated with solid waste management. In collection, total costs must include all cost components for full time and temporary equipment and personnel. By proper analysis of full costs of the current collection system, the savings that can be realized through improvements in collection efficiency and the service fees that need to be charged can be calculated.

3.2 Determine Required Collection Equipment

In its most simplistic form, collection consists of a collector or collection crew that moves through a collection service area with or without a vehicle for collecting waste materials from generators or from communal containers. Vehicles used in this process may range from small and simple to large complex automatic compaction trucks such as those used in many industrialized cities for curbside collection. Collection vehicles used in any area must be appropriate to the terrain and roads over which they must travel, the density of the service areas, the type and quantity of waste that must be collected, the strength and work habits of the collection crew, and distance to the disposal location. The following are important principles to be used in selection of vehicles.

1. Vehicles should be selected that use the minimum amount of energy and technical complexity to collect the solid waste efficiently.
2. Locally made equipment, traditional vehicle design and local expertise should be used in securing collection vehicles.
3. Equipment should only be selected that can be serviced and repaired locally and for which spare parts are readily available.
4. Muscle or animal powered vehicles or light trucks should be considered for primary collection in crowded areas or those with hilly terrain or in informal settlements.
5. Non-compactor trucks or dump trucks should be considered where the population to be served is dispersed or where the waste material is dense or where versatility is important.
6. Hybrid systems may be considered where satellite muscle or small vehicles are used to feed larger compactor type vehicles within collection routes.
7. Compactor trucks should be considered in industrialized urban areas where roads are paved and where collection routes serve many generators and waste is not dense or too wet.

Designing a collection system means making decisions regarding the method of collection, the type and number of vehicles to be used and the extent of labor to be employed. In most developing countries wage rates are low while vehicle and equipment costs are high. Therefore, primary collection systems that yield high vehicle productivity even at the expense of labor productivity often prove to be most cost-effective.

Generally, when haul distances do not exceed 20 kilometers, adequately powered non-compaction and compaction vehicles are used to haul wastes directly to disposal sites. Optimizing crew size so that overall vehicle and labor costs are minimized best maximizes vehicle productivity.

In reviewing the transfer approach that will be best for the provision of an effective solid waste collection services, consideration has already been given to the differences between collection containers and transfer stations as the point of interface between the primary collection and secondary transfer systems. The following table presents the comparative properties of each approach.

Figure 3-1 – Collection Crew with Open Truck

Table 3-1
Central Container and Transfer Facility Comparison Chart

Central Container	Transfer Facility
Serves a given area of a municipality or village	Serves several neighboring municipalities and villages
Is likely to be located within the borders of a municipality or village	Is likely to be located outside the limits of municipalities and villages
It is possible to change its location based on trial and error	Changing its location would result in costs to build new engineered facilities
A special truck hauls it "as is" to the landfill and returns it to the same location on a pre-set schedule	Depending on its design, may or may not contain large container(s) that would be hauled to the landfill
No need to weigh waste coming to it	Need to weigh waste coming to it (since it originates from several local governments)
Local government is responsible for bringing the waste to it at specific times	Local government is responsible for bringing the waste to it, either at specific times or any time depending on the design (e.g., presence of weighing machine and operators on a continuous basis)
Waste brought to it either by manual workers or transported by vehicle (e.g., tractors-trailers)	Waste brought to it by transportation vehicles only

3.3 Determine Required Collection Personnel

One basic factor in determining the cost and efficiency of primary collection programs is the size, capability, and motivation of the collection crew. The optimum crew size depends on labor and equipment costs, collection methods (curbside, communal containers, etc.) and route characteristics.

3.4 Determine Effective Collection Routes

Collection Service Areas - The collection service area is an area that falls within the jurisdiction of a government agency or private company and is often defined by political or geographical boundaries. For definition of the technical aspects of a collection system, these limits as well as location of and routes to disposal sites, transfer stations or waste processing plants should be marked on an overall service area map that will be used for a number of purposes in planning and design. Dividing a service area into zones for daily service sets up collection zones. So as to balance the system to maintain high productivity, the average number of households assigned to each collection zone should be approximately equal.

Each zone may be divided into an optimum daily workload for each collection vehicle and crew. This subdivision should be aimed at assuring that communal containers are serviced on a programmed and consistent basis. The definition of collection zones allows the solid waste manager to estimate the number and size of trucks needed to collect waste in any particular area, evaluate crew performance and to balance or equalize the workloads between the areas.

Major considerations in the development of the balanced districts in curbside collection are the productivity of the crew and the on-route time. Increases in either will lower the costs associated with collection. On-route time is productive time and should be maximized to allow the collection crew to collect as many stops (or communal containers) as possible in a given workday. Generally the major variable in on-route time is the time actually spent in travel to and from a disposal site.

Collection Routes - Within a collection zone, collection is structured into routes. <u>A route is the path followed by a single collection vehicle for waste collection on a single day.</u> The objective of routing is to direct the collection vehicle through the zone so that wasted time is kept at a minimum. Routing can be applied to trucks and crews performing curbside collection and to those that are servicing communal containers.

In routing analysis, maps should be prepared showing the number and type of collection stops per street segment or the number and location of communal containers. Where curbside collection is considered, the map should also reflect roadways with specific characteristics such as dead-end streets or particularly busy streets. Each street segment should show truck direction by arrow and whether one or both sides of the street can be collected on a pass.

In curbside collection, routes can be set by a number of different methods including 1) trial and error, 2) computer analysis, or 3) heuristic methods. The heuristic approach consists of applying experience, common sense and certain rules of thumb (or “heuristics”) to develop an acceptable, but not necessarily best, solution to solid waste collection routing. Heuristic routing was developed by the United States Environmental Protection Agency in the mid-1970’s as a compromise between trial and error and computer approaches. While heuristic routing is more precise than trial and error methods, it requires less preparation time and technical resources than computer analysis. The heuristic method of designing collection routes is a good tool for solid waste managers to analyze curbside collection. The heuristic method uses specific routing guidelines as follows:

1. Routes should not be fragmented or overlapping. Each route should be compact consisting of street segments clustered in the same geographical area.
2. Collection plus haul time should be reasonably constant for each route.
3. The collection routes should begin as near the garage or truck point of origin as possible.
4. Within the route, right hand turns are preferred to left-hand turns because of their greater efficiency.
5. Heavily travel streets should not be collected during rush hours.
6. One-way streets are best collected by starting near the upper end of the street working down through a looping process.
7. Dead-end streets should be considered as a segment of the street they intersect. They must be collected by driving down, backing down or making a u-turn. Left turns may be kept to a minimum by collecting dead-end streets when they are to the right of the truck.
8. Steep hills should be collected on both sides of the street while the truck is moving downhill for safety, loading ease, collection speed, vehicle wear, and fuel conservation.
9. Higher elevations should be at the start of a route.
10. For collection from one side of the street at the time, it is generally best to route with clockwise right turns around blocks.
11. For collection from both sides of the street at the same time it is generally better to route with long, street paths along the grid before looping clockwise.
12. For certain block configurations within a route, specific routing patterns should be applied.
13. Residents should be asked to place their waste on specific streets to eliminate the need to transverse and intersect streets.

This type of analysis forms the basis by which solid waste managers can continually review their route structures to determine what improvements to a level of service or cost savings can be accomplished by modifications. A new analysis and change in configuration (rerouting) of collection routes should be considered whenever there is a significant change in the collection system. These changes can include:

1. Frequency of collection;
2. Point of collection (curbside, alley, backyard or communal container);
3. Crew size;
4. Truck size or equipment type;
5. Location of processing and disposal sites;
6. Type of storage containers used; or
7. Number of services.

3.5 Determine Optimum Collection Frequency And Schedules

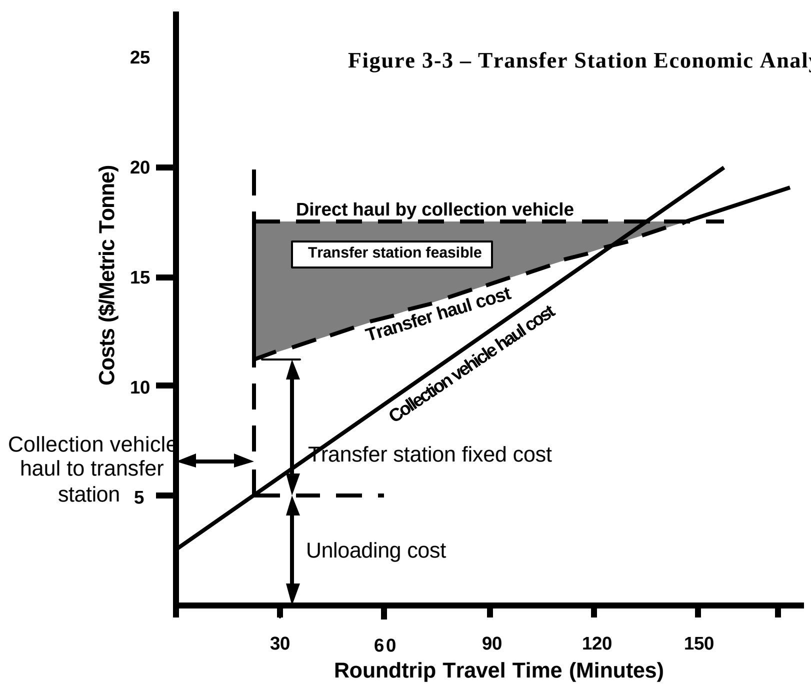
he frequency at which solid waste is collected is an important factor in defining collection cost and efficiency. In many tropical cities, curbside collection occurs as frequently as once a day. In most industrialized countries, collection occurs once or, at most, twice per week. One advantage of communal containers is that generators can bring waste to the container anytime. As a result, household storage does not become a problem. However, a problem can occur if the collection schedule for the communal containers is not sufficient to keep them available for waste placement. Sound practice in collection frequency must include an analysis of the needs and desires of the community, the health risks associated with less frequent collection, the importance of nuisance issues such as odor and, finally, the necessity of scheduling collection at times when the streets are not crowded.

3.6 Evaluate the Effect of Transfer on the Cost and Efficiency of Collection

All refuse collection vehicles have an operational radius within which they are cost-effective. This operational radius is a function of the type of truck and the amount of waste collected. Generally, if the travel time to the point of disposal is equivalent to or greater than half the daily loading time, a form of transfer should be considered. Although transfer operations offer potential savings, they involve an additional handling step with an associated. Therefore, the economics of building and running a transfer stations must be thoroughly evaluated to verify that this is the most cost effective manner to get the waste to a disposal location.

Figure 3-2 – Transfer Truck with Trailer

Figure 3-3 – Transfer Station Economic Analysis Example



ECONOMIC ANALYSIS FOR TRANSFER STATION SITING

Transfer refers to the movement of waste materials from a primary collection vehicle to a secondary (generally larger and more efficient) transport vehicle through a transfer station or consolidation containers for transport to a disposal site. While all solid waste systems usually include collection, they may not include transfer depending on the proximity of disposal location to collection points or routes. The location of transfer stations should be based on the following factors:

1. The neighborhood in which the transfer station is located should be willing to accept the transfer point as designed.
2. Odor noise and increased traffic should be minimized during the operation of the station.
3. The station should be close enough to the collection area so that the primary collection vehicles can quickly return to their collection routes.
4. The site should have easy access to major roads.
5. An analysis of haul time from collection locations and routes to disposal location will determine the time that can be saved through transfer.

In many large and heavily populated areas or in regions with dispersed population centers, more than one transfer station may be required. The appropriate number of transfer stations will depend primarily on the number and size of individual service areas and zones and the distance between them. A transfer station may include compaction to increase the volume placed into a transport vehicle for efficient transfer.

There are a number of environmental benefits of transfer. Transfer stations help reduce air emissions and fuel consumption and access to solid waste at the transfer station may help increase recovery rates. The availability of transfer also will allow landfill locations to become less independent on considerations of accessibility by collection vehicles. This allows disposal locations to be sited with more consideration for public health and environmental factors rather than their location in proximity to waste generators.

Transfer Station Design - Transfer stations should be designed to be convenient and safe with appropriate storage for the solid waste received from the collection routes. The operating scheme should be as simple as possible and should require a minimum of waste handling while offering the flexibility to modify the facility when needed. The following is the general criteria for transfer station design:

1. **Site** - The site for transfer stations must be large enough to accommodate buildings, waste storage, vehicle maneuvers, and potential for expansion. To the degree possible, the site should have sufficient elevation change to accommodate a two-level building or site design.
2. **Transfer Techniques** - There are three types of transfer stations commonly used where collection vehicles discharge waste 1) onto a tipping floor, 2) into pits or hoppers or 3) directly into transfer trailers. When vehicles are emptied onto a tipping floor, additional equipment such as a front-end loader is needed to push the waste into the receiving transfer vehicle or into a hopper of an external compactor. Basic criteria for each type of transfer station is as follows:

   Open tipping floor transfer stations

   - Usually more efficient for small quantities of solid waste

- Can be used to transfer different materials into different vehicles
- Can easily accommodate recovery of materials with recycle value
- Allows for waste picking during transfer
- Maximizes the possibility of spreading out the waste so as to dry it out prior to transfer

Open pit transfer stations

- Allows multiple collection vehicles to offload at the same time.
- Can accommodate larger collection vehicles.
- Higher capital and operating costs than open tipping floor concepts
- Preprocessing and separation of recoverable materials is difficult.

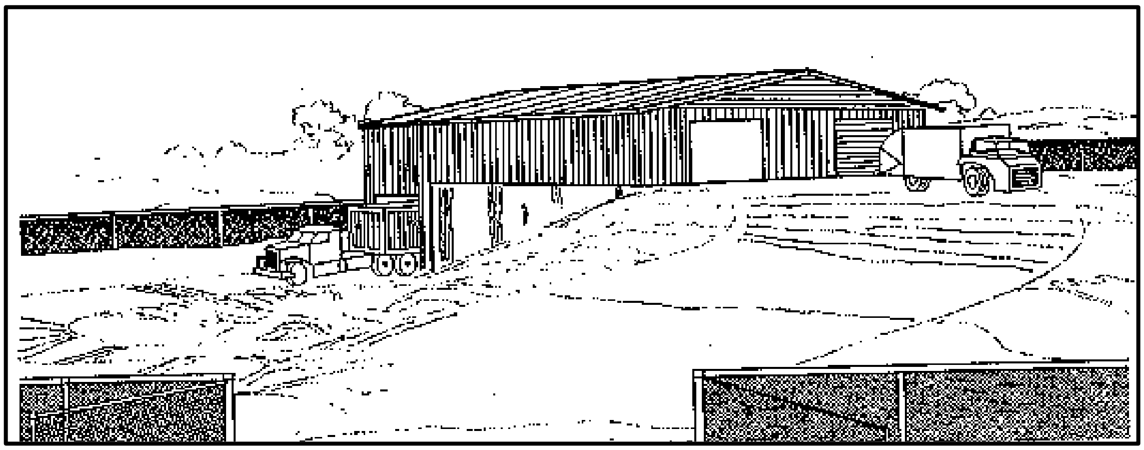


Figure 3-4 – Multi-level Transfer Station

Direct dumping transfer stations

- Have no intermediate handling which increases efficiency and decreases labor
- Does not permit waste picking

- Requires bi-level construction with receiving trailers at a lower level
- Can be quickly constructed or moved and are relatively inexpensive
- Requires sufficient number of trailers depending on amount of waste received and the distance to processing or final disposal.

Typically, small transfer stations are direct-discharge stations that provide no intermediate waste storage area. These stations usually have drop-off areas for use by the general public to accompany the principal operating areas dedicated to municipal and private refuse collection trucks. Depending on location, site aesthetic requirements, and environmental concerns, transfer operations of this size may be located either indoors or outdoors. Most transfer stations are usually attended during hours of operation.

Smaller transfer stations used in rural areas often have a simple design and are often left unattended. These stations consist of a series of open-top containers that are filled by station users. These containers are then emptied into a larger vehicle at the station or directly hauled to the disposal site and emptied. The required overall station capacity (i.e., number and size of containers) depends on the size and population density of the service area and the frequency of collection. For ease of loading, a simple retaining wall will allow containers to be at a lower level so that the tops of the containers are at or slightly above ground level in the loading area.

Factors that should be considered in determining the appropriate size of a transfer facility include:

- Capacity of collection vehicles using the facility,
- Desired number of days of storage space on tipping floor,
- Time required to unload collection vehicles of all types used in the collection system,
- Peak number of vehicles that will use the station and their hours of arrival,
- Waste sorting or processing to be accomplished at the facility, if any,
- Transfer trailer capacity (in use and standby),
- Hours of station operation, and
- Time required to load and haul trailers.

Figure 3-6 – Outdoor Multi-Level Transfer Station with Load Lugger Vehicle

Transfer Station Development Procedures

Step 1: Assess Waste Transfer Applicability – The intent of the first step is to determine if the benefits of transfer outweigh the costs. This can be determined by accomplishing a break-even analysis. The factors that go into such an analysis include the following:

1. Transfer station and processing/disposal site locations.
2. Average payloads of collection vehicles and transfer vehicles.
3. Travel speeds and distance for haul vehicles.
4. Transfer facility size, technology, and operating practices.
5. Collection and transfer vehicle operating costs.

To calculate the break-even point for waste transfer, first determine the following values:

- Transfer Station Cost: cost to build, own, and operate transfer station, in Rp. per ton.
- Direct Haul Payload: average payload of collection vehicle hauling directly to landfill, in tons.
- Transfer Haul Payload: average payload of transfer truck hauling from transfer station to landfill, in tons.
- Transportation Cost: average cost of direct or transfer hauling, in Rp. per km.

Once these values are known, calculate cost for different transport distances to disposal areas. The first calculation would be for the cost of direct haul without the transfer station which is calculated through the following formula:

$$\frac{\text{Distance (km) x Transportation Cost (Rp./km)}}{\text{Direct Haul Payload (tons)}}$$

The comparable cost with the incorporation of a transfer facility can be calculated using the following formula:

$$\frac{\text{Transfer Station Cost (Rp./ton) + Distance (km) x Transportation Cost (Rp./km)}}{\text{Transfer Haul Payload (tons)}}$$

In developing the break-even analysis, a graphical representation of the costs can be developed. An example of such a diagram is shown in the following figure. If the distance from the end point of all of the collection routes to the processing/disposal facility is **less** than the break-even distance calculated, then there is no benefit from waste transfer. However, if the distance from the end of some or all of the collection routes **exceeds** the break-even distance calculated, then there is potential benefit.

Step 2: Develop Conceptual Design – If clear economic benefits can be determined through the above analysis, then the next step should be undertaken. This involves the development of a conceptual design that seeks to answer the following questions:

1. What types of waste and/or recyclable materials will the transfer station accept?
2. What average volume of material will the transfer station manage?
3. How much waste will the facility receive during peak flows?
4. Will the transfer station receive waste from the general public or limit access to governorate and/or contractor waste collection vehicles?
5. What additional functions will be carried out at the transfer station (i.e., material recovery programs, special waste handling, and vehicle maintenance)?
6. What are the characteristics of the collection vehicles that will use the facility?
7. How much waste storage space is needed?
8. What type of transfer technology will be used?
9. How will waste be transported after transfer? Truck or rail?
10. Who will be allowed to use the Facility?

11. What Materials will the transfer facility accept? Commonly accepted materials include: municipal solid waste, green waste, household hazardous waste, recyclable materials, construction and demolition debris.

Step 3 - Determine Transfer Station Size and Capacity – There are a number of factors that influence transfer station size and capacity including:

1. The definition of the service area.
2. The amount of waste generated in the service area.
3. The number and types of vehicles delivering waste.
4. The types of materials to be transferred.
5. The availability of transfer trailers.
6. Waste tonnage projections over station life.
7. The relationship to existing and proposed facilities.

3.7 Implementing an effective collection system

As with most alterations in a solid waste collection system, a change in routing or collection frequency affects at least three groups of people: 1) those responsible for the solid waste collection and transfer program, 2) the solid waste collection crews, and 3) the waste generators. An information education program should properly inform each of these groups about what is expected of them and enlist their cooperation in accomplishing the desired change and in the performance of the collection process.

The solid waste collectors and drivers should be informed of all proposed changes to the collection system and encouraged to comment on the effect of the changes will have on their daily operations. Their criticisms or suggestions for further improvement are essential to the final evaluation by the solid waste managers. In addition to being a potential source of pertinent input, the workers' participation in reviewing the decisions may be a useful managerial tool in that it helps them feel a part of the new system and more in support of the change that may be required. Several mechanisms can elicit cooperation from the collection personnel and help improve or maintain employee morale during and after implementation.

Other public officials (particularly elected officials) also should be apprised of the proposed changes as the new transfer system is implemented. If the reasons for the changes in the collection system are explained to them, they often are important allies during the transition. Should they be approached by waste generators regarding the changes, they should be aware of what is taking place.

The implementation of the technical portions of the new collection/transfer approach will be phased as the need for transfer evolves due to the development of the regional landfills and the closure of the uncontrolled dumps. As a result, solid waste managers will need to plan their system modification service area by service area. An overall plan should be developed defining the technical changes to be accomplished and the schedule for procuring necessary resources and putting them into service.

4. OPERATING AND MAINTAINING AN EFFECTIVE COLLECTION SYSTEM

4.1 Manage Collection System Operations

An effective solid waste collection system requires firm and thorough administration and control of operations. This administration and control must include close coordination between the local governments and the SWM Councils to assure that their respective programs operate seamlessly.

From the perspective of managing each component, effective administration and control requires that all personnel involved in the process be held accountable for their performance. To achieve this, administration should, at a minimum, include record keeping, direct monitoring of system performance through inspections and observations, supervision of maintenance, dedication of standby equipment, and effective cost accounting.

Record keeping is very important in monitoring and documenting the performance and, hopefully, effectiveness of a collection program. Without proper records, productivity measurements, evaluations, cost studies and preventive maintenance would be impossible to accomplish to the degree necessary to maintain a good level of service. Records that should be routinely kept by a collection manager include:

1. Route maps
2. Vehicle records including purchase data, maintenance and repair record, fuel consumption records, accident reports, operating hours, on route hours, time to disposal sites and return
3. Crew records including amount of waste collected per day, households collected per day, other stops collected per day, truck assignment, time on-route, time off-route
4. Load records including weight, number of trips to disposal per day, percentage of full capacity, etc..

These records are important to monitor the performance of the collection program. They also serve as the basis for planning and design of service expansions and new facilities such as transfer stations and disposal sites

4.2 Train personnel

All collection personnel need to be trained in the performance of the duties. The training should define the level of productivity expected of them. At a minimum, training should be provided for the following:

- Routing structure and expected collection productivity
- Record keeping
- Health and safety
- Contingency Procedures
- Operations and maintenance of collection equipment
- Operations and maintenance of transfer stations

In addition to the above base training, specialized training should be provided to program managers who will be responsible for monitoring and inspecting system performance. This training should also include training is design such as routing analysis to allow for continual tracking of performance and system needs identification. Training should also be provided to personnel responsible for maintenance of all collection equipment.

4.3 Educate Waste Generators About Their Role In Effective Collection Practice

To maintain program effectiveness, an education program should be directed toward waste generators. Several media are available to accomplish this. One of the best is a letter from the appropriate public official explaining the reasons for any changes in collection methodology and schedules and how the changes may affect the waste generators. Other methods that can effectively inform the public include articles and notices printed in local newspapers. Depending on the nature of individual service areas within the primary collection systems, community organization and NGOs may provide some assistance in educating the public as to their new role in the collection program.

4.4 Develop Contingency Procedures For Unusual And Special Circumstances

Effective collection and transfer requires that contingency procedures be established for any unusual and special circumstances. At a minimum, contingency procedures should be established for the following:

Accidents - Given the nature of motor vehicles and the collection process, accidents may be expected to occur. These accidents may solely involve collection system vehicles and personnel but may also involve others. Any accident should be immediately reported and investigated to determine its extent and cause. Contingency procedures concerning accidents should be a function of the severity of the accident. All personnel should be trained as to any contingency procedures to be used in the event of an accident. Collection crews should be particularly trained as to the procedures in the event of an accident where somebody is seriously hurt. In the case of a life-threatening situation, personnel should be prepared to take required actions including emergency first-aid and the immediate notification of other sources of emergency assistance.

Complaints - Complaints may be received concerning the collection system. All complaints should be logged and investigated. As is the case with procedures to address accidents, complaints should be evaluated to determine their cause and to address the reason for the complaint. Adjustments may be made to the collection program to eliminate the cause of justifiable complaints especially those that are recurring. As a contingency procedure, solid waste managers should be prepared to address issues such as overflowing containers or the accumulation of solid waste in areas where it is not intended. It is extremely important that such complaints be addressed in a timely manner since a small accumulation of solid waste in an uncontrolled location can become a major project to clean-up if allowed to grow.

4.5 Develop And Manage An Effective Maintenance Program

The successful operation and productivity of any collection or transfer system is dependent on the manner in which its various equipment is maintained. In addition to proper maintenance, sufficient back-up equipment must be available to assure that each collection cycle can be achieved with a minimum of variation in the service schedule. Effective routing, operation, preventive maintenance and repair work can contribute to increasing long-term vehicle productivity.

Types of Maintenance - There are two types of maintenance that need to be done on a day-by-day basis including repair maintenance and preventative maintenance. Experience has shown that wherever a mechanized equipment is used, there is a direct relationship between the degree of preventative maintenance and the level of repair required. Logically, there is a level of preventative maintenance where the cost effectiveness of a maintenance program is lost. An extremely high level of preventative maintenance can theoretically lead to performance levels where few breakdowns in mechanical equipment are experienced. The cost of this idealistic level of preventative maintenance, however, is prohibitive. Similarly, the cost of repair maintenance, where little or no preventative maintenance is done, may also be prohibitive. The design of an effective maintenance program attempts to establish the optimum balance between repair and preventative maintenance that would be most cost effective.

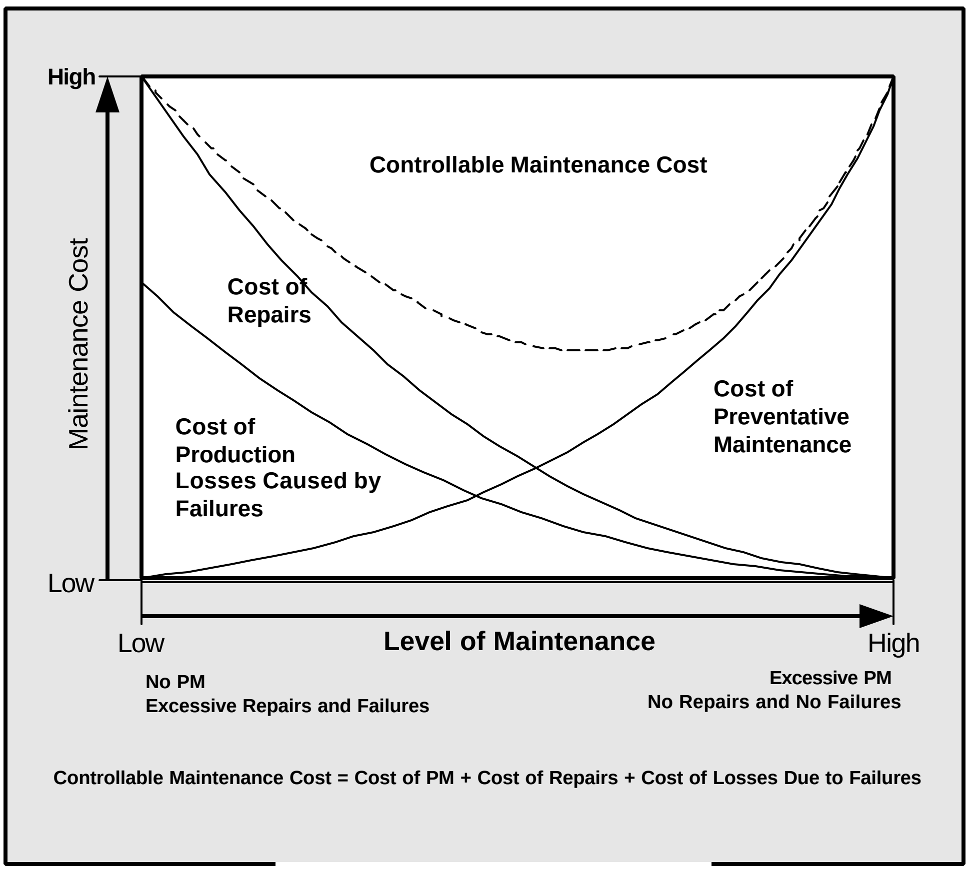
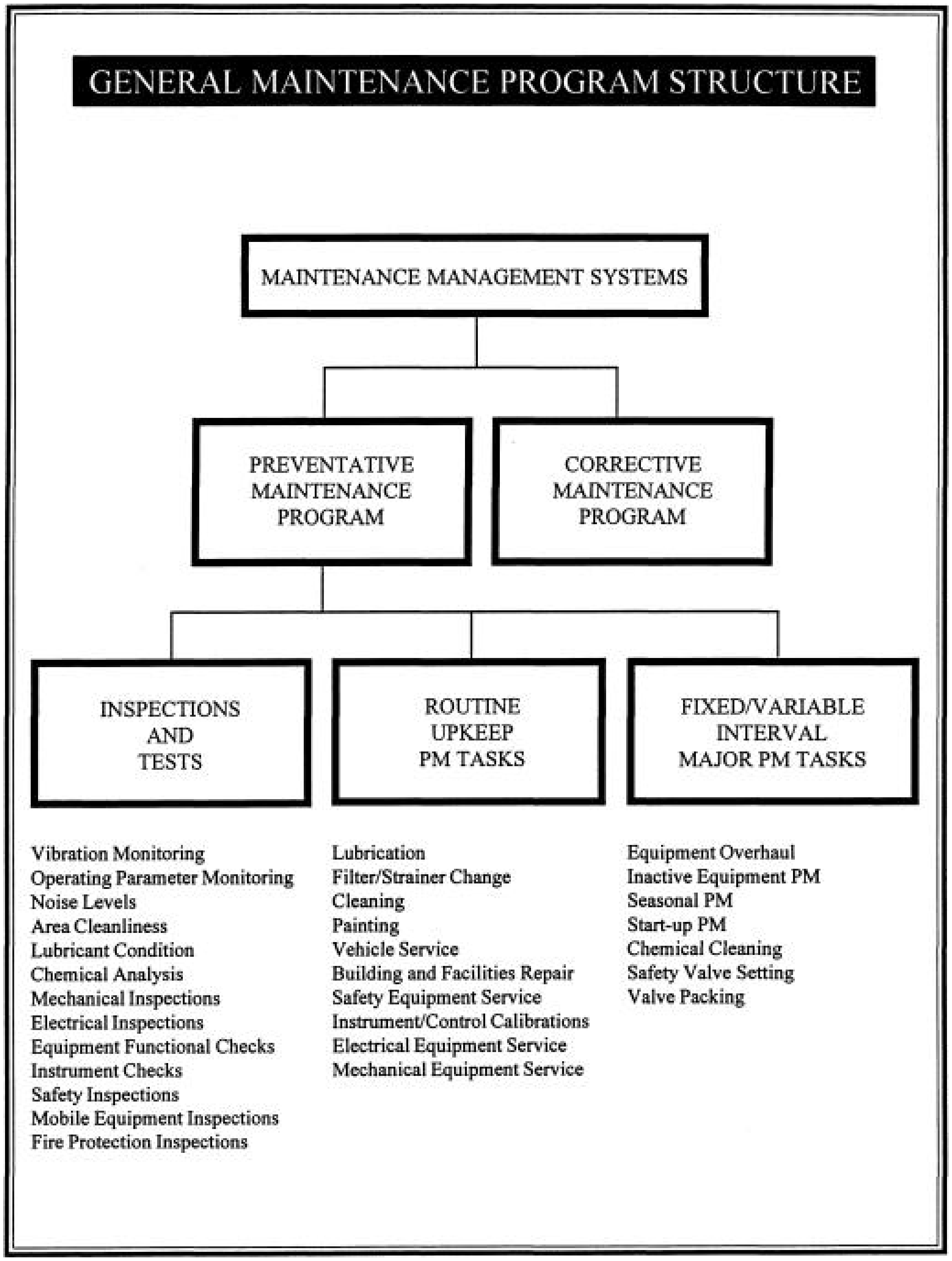


Figure 4-1
Preventative Maintenance Economic Model

Repair Maintenance - Repair or corrective maintenance consists of making repairs when they are required because of equipment breakdown. Since breakdowns cannot be planned, the consequential loss of some equipment as a result of repair downtime must be added to the overall cost of a repair to determine the full economic impact of breakdowns. Additionally, backup equipment is required so that the level of service is not affected by equipment breakdowns.



Preventative Maintenance – By definition, preventative maintenance consists of the following:

1. Periodic inspection of equipment to uncover conditions that could eventually lead to breakdowns or harmful depreciation.
2. The avoidance of future difficulties by making minor repairs in advance of major problems.

3. Replacements, adjustments, major overhauls and inspections that are preplanned and scheduled on a cycle that will maintain equipment at the optimum operating efficiency.
4. A policy of operating equipment properly and within its range of design capability.

An effective maintenance program design normally assumes that both preventative and repair maintenance are made part of regular operational procedures. The emphasis of the maintenance plan, however, is on the preventative maintenance program that minimizes the level of repairs required. Preventative maintenance activities are usually preplanned and scheduled, thus facilitating the programming of maintenance work. This significantly improves the planning and scheduling of all maintenance management activities. The experience gained as collection equipment is operated helps to identify "critical" equipment that should receive priority in the maintenance program. An effective preventative maintenance program is broken down into three categories including: 1) monitoring, inspections and tests, 2) routine upkeep tasks and 3) fixed and variable interval major tasks. These consist of the following:

- **Monitoring, Inspections and Tests** - The inspection of critical equipment is a key part of any PM program. The purpose of inspection is to identify and correct unfavorable conditions that may be developing. This can help prevent breakdowns. Inspection activities may be accomplished in a variety of ways such as visual inspections, monitoring of normal operating parameters, measuring and analyzing data, and the performance of specific tests.
- **Fixed and Variable Period Maintenance** - The performance of routine periodic maintenance improves its reliability and extends service life by maintaining optimum equipment conditions. The routine upkeep tasks on a specific piece of equipment usually require a short time to complete and are normally conducted on a regular schedule. Typical routine upkeep tasks on motorized equipment can include: 1) lubrication, 2) filter/strainer change/cleaning, 3) cleaning and painting and 4) vehicle service.
- **Major Preventative Maintenance Tasks and Overhaul** - The final category of activities is fixed and variable interval major preventative maintenance tasks. Major mobile equipment is routinely removed from service for extended periods for inspection and overhaul. The frequency and duration of such overhaul periods varies with the equipment.

So as to establish the control and management accountability required in a good preventative maintenance program, checklists and records of task performance should be used to maintain a database of all work done. Maintenance staff and equipment operators should be required to complete checklists of the tasks that they perform.

Standby equipment - Solid waste collection is a difficult process and equipment used within the collection system will often break down. To maintain a proper level of service, standby equipment may be required so that collection can still occur even when primary equipment is broken down with minimal disturbance to the pattern and schedule of collecting solid waste. In industrialized countries, the target level of standby equipment is to provide at least one standby vehicle for every five vehicles used daily.

4.6 Monitor system performance and adjust collection system as necessary

Reducing collection costs by improving collection efficiency must begin with a thorough understanding of the activities that occur during the collection day. The collection day can be divided into two broad categories for purposes of analysis:

1. Time spent on nonproductive activities when the collection crew is not occupied with collecting waste from collection routes or communal containers
2. Time spent actually collecting waste along the collection routes or in servicing container locations.

Allocation of the work day among all the productive and nonproductive activities can be determined by recording the amount of time personnel spend on each activity from the moment they start work in the morning to the moment when they leave work at the end of the day. For the purpose of an example that relates to curbside collection, primary collection day activities can be subdivided into:

- Time at the yard at the beginning and end of the day
- Commuting time to the route at the beginning of the day and back to the yard at the end of the day
- Vehicle unloading time at the transfer, processing or disposal facility including travel to and from the facility
- On-route time performing collection activities

The following areas of unproductive time deserve particular attention in monitoring the performance of a collection system:

- Collection routes should be assigned in advance of the collection day so that each crew knows where they're going for the day. Contingency plans for sick days or other absences should also be planned in advance.
- Where possible trucks should be assigned to a single driver over an extended period of time, so that time is not lost changing mirrors getting personal items out of trucks and rechecking engine fluids and equipment. Note that this also makes it easier to track driving habits to assign blame and praise for high and low maintenance on individual vehicle.
- Routine maintenance should be accomplished at the end of the collection day preferably by maintenance crew rather than the driver.
- The number of trips off route to empty a full truck should be reduced by increasing truck size or compaction of materials than can be compacted.
- Weighing and unloading bottlenecks at the materials processing or disposal facility should be eliminated either through redesign of these areas or through staggered scheduling of truck deliveries.
- Routes between the yard and delivery points in the collection routes should be evaluated to minimize off route travel distances into assure that, to the extent practical, trucks are routed around slow-moving traffic areas.

By regularly monitoring the time spent on various activities, a collection program can be effectively monitored to assure maintained productivity. After a while, a level of performance productivity will be obvious to solid waste managers so that it can be monitored. If the system is designed properly and sufficient resources are available, evidence of system failure (solid waste accumulation outside of containers, inconsistent service, complaints, etc.) will be an indication of productivity slippage thereby warranting closer investigation of system productivity and asset management.

5. KEY SOLID WASTE MANAGEMENT STRATEGIC ISSUES

There are a number of key overriding issues that may influence the manner in which solid waste collection is altered or enhanced. These are summarized below:

5.1 Private Sector Involvement

In the future, the role of the private sector in solid waste management may become more prominent in Indonesia. In many countries, private companies have been able to bring the required capitalization and operating efficiencies that have helped municipalities save money while achieving better SWM results. However, experience with such approaches has been minimal in Indonesia.

A private contractor might provide a means for incorporating more sophisticated technology in achieving solid waste collection, treatment or disposal. However, asking a private contractor to bring in new equipment that would increase SWM effectiveness and efficiency requires a clear recognition that this new equipment and improved services may increase the costs to be borne by the municipality and its residents.

Utilization of a private contractor also allows the establishment of performance standards that the contractor is required to follow. Performance standards may be defined in the contract that they may sign for the work. For example, if BPK hired a private contractor to perform container collection services, the BPK could require a minimum level of service as a condition of the contract. This would allow BPK to monitor performance of the contractor for good service. In many areas where private sector contracts have been established, penalties are often stipulated in contracts for poor performance. This serves as an incentive to maintain the desired level of service.

Currently, there is also a potential role for micro-enterprises in Manado to provide door-to-door collection services in each kelurahan. One issue that would need to be evaluated would be the manner in which these micro-enterprise contractors would be paid. There are two basic alternatives that can be considered. In the first, the contractor is paid directly by the residential or commercial waste generator for the service of collecting the solid waste every day and bringing it to a TPS. In the second alternative, the kelurahan pays the contractor to perform the required door-to-door service. In turn, the kelurahan would seek to collect a fee from generators for the government sponsored service.

5.2 Public Awareness, Cooperation and Participation

Strong public awareness of solid waste management issues is critical if Manado's current solid waste problems are to be corrected. Public attitudes towards litter and the improper dumping of solid waste must be adjusted so as to not place an additional burden on the collection program. The public awareness program needs to create a clear link between the roles that each residential solid waste generator has in the efficiency of the overall collection system and its success. It also needs to create a means by which generators can feel that they “own” the solutions that are implemented. This requires that the means for soliciting public input into the SWM planning process be developed.

One of the key aspects in gaining public acceptance of any new approach toward solid waste collection is to make sure that the proposed system meets the perceived needs of the community. In low income areas, solid waste management may not the highest priority. For example, a survey was conducted in Yogyakarta, Indonesia showed that expenditures such as those on food (which may be as high as 50 to 80% of incomes), housing, clothing, electricity and education were viewed to be higher priorities than solid waste management. This often places the views of community members at a different focus than those of decision makers who are more likely to focus on environmental protection and public health issues. While it's important to make sure that residential generators are aware of the negative aspects of improper solid waste management, it is also extremely important that any new or enhanced collection system meets their perceived needs which may be more oriented towards convenience and anesthetics.

It's also important to recognize that solid waste management collection requires the significant participation of residential generators who may be involved in storage of the waste in households, transporting of the waste to roadside or communal containers, and the payment of user fees. Because of this, the capacity and willingness of households to contribute to the service is extremely important. This, therefore, establishes a priority for low-cost rather than high technology solutions that might be prevalent in more industrialized countries.

The public awareness program should also attempt to create a clear link between the actual cost of a reasonable level of collection service and generator willingness to pay. Throughout the world, experience has shown that people are willing to pay more for an improved level of service. However, in some locations, fees have increased without realizing a significant improvement in service. This then became an impediment to creating additional revenues required to enhance services.

There are numerous forms of community participation including:

- Individual participation
- Collective participation
- Material or financial contributions
- Active participation in formulating projects

Each of these should be part of the city's solid waste management program.

5.3 Cost Recovery and Financial Resources

To the degree possible, there should be a clear link between the actual cost of solid waste collection services and the revenues that generators must pay for them. The ideal situation would be where revenues derived for SWM services would be equal to the overall costs of the program. Residential generators must be educated to the fact that there are different components to the SWM services that they receive. For example, a direct payment for door-to-door collection is solely for that service whereas the actual cost of solid waste collection borne by the kecamatan and the cost of operating the TPA by the BPK must also be funded in some manner such as the collection of Retribusi collected in conjunction with the utility bills.

Cost recovery mechanisms often used in SWM are shown in the following table which also presents a summary of experience with use of these mechanisms across the world. It is noteworthy that all of the mechanisms are difficult to implement from a political perspective. However, since the City has already established a basis of collecting SWM fees through the utility bill, the opportunity to increase fees to the level required for an effective service may already exist.

Table 3.2

SWM Cost Recovery Options

Mechanism	Can adequate revenues be generated?	Can the revenues be easily collected?	Does the polluter pay more?	Is it politically difficult to use this mechanism?	Is the mechanism easily enforced?
USER CHARGES					
Solid Waste Tax	Yes	No	Not Always	Difficult	No
Volumetric Charges	Yes	No	Yes	Difficult	No
Tipping Fee	Yes	Yes	Yes	Difficult	Sometimes
OTHER SOURCES					
Property Tax	Yes	Yes	No	Difficult	No
Business License Fees	Yes	Yes	No	Difficult	Yes
Utility Surcharge	Yes	Yes	Not Always	Difficult	Yes
Grants and Donor Support	Yes	Yes	No	Difficult	No